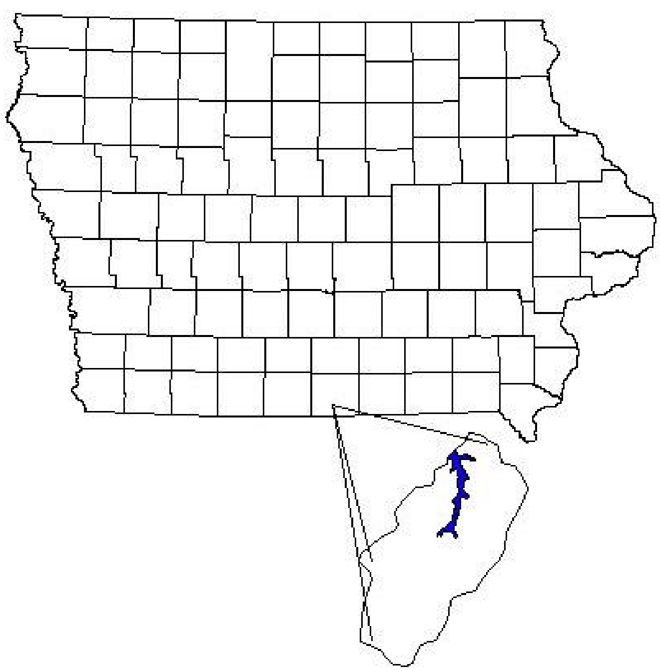
Total Maximum Daily Load
For Siltation
Bob White Lake
Wayne County, Iowa

December 13, 2001

Iowa Department of Natural Resources
Water Resources Section

TMDL for Siltation
Bob White Lake
Wayne County, Iowa

Waterbody Name:	Bob White Lake
IDNR Waterbody ID:	IA 05-CHA-00690-L
Hydrologic Unit Code:	HUC11 10280201010
Location:	Sec. 4, T68N, R22W
Latitude:	40 Deg. 41 Min. N
Longitude:	93 Deg. 24 Min. W
Use Designation Class:	A (primary contact recreation) B(LW) (aquatic life) C (potable water source)
Watershed Area:	3,463 acres
Lake Area:	89 acres
Major River Basin:	Southern Iowa River Basin
Tributaries:	South Fork Chariton River
Receiving Water Body:	South Fork Chariton River
Pollutant:	Siltation
Pollutant Sources:	Agricultural Nonpoint
Impaired Uses:	B (LW) (aquatic life)
1998 303d Priority:	Medium



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1. Introduction

The Federal Clean Water Act requires the Iowa Department of Natural Resources (DNR) to develop a total maximum daily load (TMDL) for waters that have been identified on the state's 303(d) list as impaired by a pollutant. The purpose of this siltation TMDL for Bob White Lake is to calculate the maximum amount of a sediment that the lake can receive and still meet water quality standards, and then develop an allocation of that amount of sediment to the sources in the watershed.

Specifically this siltation TMDL for Bob White Lake will:

- Identify the adverse impact that siltation is having on the designated use of the lake and how the excess load of sediment is violating the water quality standards,
- Identify a target by which the water body can be assured to achieve its designated uses,
- Calculate an acceptable sediment load, including a margin of safety, and allocate to the sources, and
- Present a brief implementation plan to offer guidance to Department staff, DNR partners, and watershed stakeholders in an effort to achieve the goals of the TMDL and restore the lake to its intended use.

Iowa DNR believes that sufficient evidence and information is available to begin the process of restoring Bob White Lake. The Department acknowledges, however, that to fully restore Bob White Lake additional information will likely be necessary. Therefore, in order to accomplish the goals of this TMDL, a phased approach will be used. By approaching the restoration process in phases, feedback from future assessment can be incorporated into the plan.

Phase I of the siltation TMDL for Bob White Lake will address the first target associated with achieving a reduction in the sediment load associated with the aquatic life impairment. Phase II will evaluate the effect that the sediment load targets have on the intended results. Included in Phase II will be monitoring for results, reevaluating the extent of the siltation impairment, and evaluating if the specific aquatic life impairment originally identified in the TMDL has been remedied. Ultimately, the intent of this TMDL is not to set in stone arbitrary targets, but restore the aquatic life that have been impaired. The phased approach allows DNR to utilize a feedback loop to determine if the initial sediment load target has been effective.

2. Description of Waterbody and Watershed

2.1 General Information and Conditions at Time of Listing

Bob White Lake is located in Wayne County in south central Iowa about 1 mile west of Allerton, Iowa. The Rock Island Railroad purchased the land for Bob White Lake in 1912, and subsequently built the lake to supply water to its steam engines in nearby Allerton. The city of Allerton purchased the water rights and pumping equipment from the railroad about 1959. Bob White Lake was used as a municipal water supply until 1982. Bob White Lake has a surface area of 89 acres, a mean depth of 5 feet, a maximum depth of 14 feet, a storage volume of 444 acre-feet. In 1961, Bob White State Park was established.

Bob White Lake is entirely within the 398 acre Bob White State Park, which is owned and managed by the Iowa Department of Natural Resources (DNR). Bob White Lake has designated uses of Class A (primary contact recreation), Class B (LW) (aquatic life) and Class C (potable water source). A swimming beach and campground are located on the northeast side of the lake. The southern portion of the lake is quite shallow, with areas that are marsh-like, too shallow for any boat, and several portions with emergent vegetation. The lake provides facilities for fishing, swimming, boating, camping, picnicking and hiking. Park use is approximately 25,000 visits per year.

The Bob White Lake watershed has an area of approximately 3,463 acres and has a watershed-to-lake ratio of 39:1. This ratio is considered high by the DNR, with the ideal ratio being closer to 20:1.

Topography of the watershed varies from nearly level to gently sloping (2-9%) Seymour-Edina soils developed from leached loess, with moderate fertility. Moderately sloping to strongly sloping (5-24%) Clarinda-Shelby-Adair soils are formed from till-derived paleosols, with low to moderate fertility. Level to gently sloping (5-14%) Lamoni soils developed from till-derived paleosols.

Average rainfall in the area is 34 inches/year, with the greatest monthly amount (5.5 inches) occurring in June.

In the late 70's a Soil Loss Complaint was filed with the Wayne County Soil Conservation District for portions of the Bob White Lake watershed. As a result numerous conservation practices and crop management systems were put in place in the early 80's. Over time many of those have lost effectiveness or have been changed.

Sediment delivery estimates can be determined by using the Erosion and Sediment Delivery Procedure, Section I, Erosion Protection (USDA/NRCS, 1998). The following equation was used to calculate sediment delivery to Bob White Lake:

Sediment Delivery (t/yr) = Drainage Area x Gross Erosion Rate x SDR
Where: Drainage Area is the subwatershed in acres
Gross Erosion in Tons/acre/year
SDR is the Sediment Delivery Rate

The sediment delivery to Bob White Lake was first estimated based on the time at which the impairment was noted in 1992. Estimates used "Predicting Rainfall Erosion Losses, The Revised Universal Soil Loss Equation (RUSLE)" Section I, Erosion Prediction (USDA/NRCS 2000) for sheet and rill erosion and "Erosion and Sediment Delivery Procedure", Section I, Erosion Protection (USDA/NRCS 1998) for the sediment delivery factors. Pertinent calculations can be found in Appendix II. These two calculations are generally accepted in the agricultural community as simple and straightforward methods for determining gross erosion and its resultant delivery to a body of water. Using landuse and practices supplied by the Wayne County Soil and Water Conservation District (Franklin, 2001), it was estimated that gross erosion was 3.3 tons/acre/year in 1992. Applying a Sediment Delivery Rate (SDR) of 34%, the result is an estimated sediment load of 3,885 t/yr from sheet and rill. Since no data is available from 1990 for erosion from streambank, gully, and ephemeral gully sources, this number was not considered. The total sediment load from the 1992 reporting period is therefore 3,885 t/yr.

2.2 Current Watershed Conditions

Using these same calculations and data provided by Wayne County for the 2000 season, the current load from sheet and rill erosion is estimated to be 2.1 t/a/yr, or 2,473 tons/year of sediment delivered to Bob White Lake. A Rathbun Lake Watershed Assessment, conducted under a grant from EPA, did actual ground measurements for the Bob White Lake watershed. The data collected was used to calculate the loads in that subwatershed from each source. The report shows an additional sediment load from streambank, gully, and ephemeral gully sources of 519 t/yr (Table 3, section 7.2 and Appendix I). That brings the total current sediment load from all sources to 2,992 t/yr.

The land uses and associated areas for the watershed are shown in the table below.

Table 1. Land use in the Bob White Lake watershed (2001).

Landuse	Area in Acres	Percent of Total Area
Cropland	2,341	68
Pasture, CRP & Hayland	347	10
Wasteland	350	10
Woodland	280	8
Other (railroad, roads, etc)	145	4
Total	3,463	100

3. Applicable Water Quality Standards

The State of Iowa does not have numeric water quality standards for siltation. In the 1992 Department of Natural Resources (DNR) biennial water quality 305(b) report the fishable uses (Class B) for Bob White Lake were assessed as partially supported due to excessive sediment from agricultural sources, based on the best professional judgement of DNR Fisheries staff. This assessment was based on information collected during the 1990-1991 period. In the 1994 report that assessment of partially supporting of Class B (LW) was changed to not supporting. The assessment of not supporting of Class B (LW) has continued to be used in subsequent biennial reports.

Excess sediment impacts the Class B (LW) designated use by altering the physical and chemical characteristics of the lake so that a balanced community normally associated with lake-like conditions is not maintained (IAC 567-61.3(1)b(7)). The altering of the physical and chemical characteristics causes impairments of the following beneficial uses: 1) aquatic habitat; 2) spawning, reproduction and development; and, 3) sport fishing. In addition, siltation reduces food supplies by smothering benthic macro invertebrates.

Bob White Lake was listed as impaired for aquatic life uses due to observations that the fishery was not consistent with similar lakes in Iowa. The catfish population is flourishing, but the bass population was skewed, showing poor recruitment for younger age classes. The bluegill population is absent. These conditions support that a problem exists. It has been determined by DNR Fisheries Staff that sediment has impacted the fishery. Sediment impact to a fishery can include loss of habitat, interference with sight feeding, and/or loss of macrophyte cover. Since incomplete information is available, additional monitoring will be a part of this phased TMDL.

4. Water Quality Conditions

Various Water Quality studies have been conducted at Bob White Lake, measuring general physical parameters often related to water clarity such as total suspended solids, Secchi Disk depth, chlorophyll a, and turbidity. The studies conducted include the Clean Lakes Classification Study by Iowa State University (ISU) (1979, 1990). Currently, in-lake water monitoring will be completed as part of the Iowa Lakes Survey, which includes sampling three times per year for each of the field seasons 2000 – 2005. Table 2 provides a summary of pertinent data collected during these studies. Data show that Secchi depth is consistently less than 1 meter. Secchi disk depth is one method used to determine water clarity. Depths of less than 1 meter are considered to be the result of excess sediment, and that condition contributes to the negative impact on the aquatic life uses. In addition to excessive sediment, turbidity can also result from algal growth caused by excess nutrient loading. Table 2 data also show elevated chlorophyll, nitrogen, and phosphorus values. However, because these relationships are complex and include factors such as light penetration, data from future monitoring will continue to assess not only sediment-related parameters, but nutrients and chlorophyll as well.

Table 2. Summary of Pertinent Data Collected During Water Quality Studies of Bob White Lake

Study Year	Total Suspended Solids*	Chlorophyll a*	Secchi Disc Depth*	Total Nitrogen*	Total Phosphorous*
1979	97.5 mg/l	10 ug/l	0.18 m	0.6 mg/l	0.21 mg/l
1986	44.4 mg/l	55 ug/l	0.15 m	3.3 mg/l	0.20 mg/l
1990 (92)	151.7 mg/l	6.9 mg/m3	0.1 m	3.3 mg/l	0.474 mg/l
2000	22.3 mg/l	11 ug/l	0.3 m	1.77 mg/l	0.362 mg/l

*mean
Note that units were reported differently during some studies. No attempt has been made to convert the values to consistent units. The express purpose of this table is to present available data and to demonstrate whether trends can be seen, not to indicate that any exist.

Most of the southern portion of Bob White Lake is shallow, averaging 2-3 feet in depth, with emergent growth along much of the shore. This allows for frequent re-suspension of sediment from various factors, such as wind and wave action. Some additional re-suspension occurs from the action of carp disrupting the bottom, but it is not a major source. Because the lake is so shallow, re-suspension from stratification due to temperature inversion or anoxic sediments (containing no dissolved oxygen) is not a factor. The primary impacts of sediment at Bob White Lake are interference with reproduction and growth of fish and other aquatic life. Excessive sediment deposition has lead to the lake being assessed as not meeting water quality standards.

It is important to note that this lake is almost 90 years old, that the life expectancy of Bob White Lake was likely exceeded many years ago, and that most of the damage has already occurred. The fact, that it continues functioning as a lake, is a credit to management practices already implemented in the watershed, and the DNR Fisheries staff. It is a goal of this TMDL to the extent possible, to prolong the life expectancy of the lake.

5. Desired Target

The listing of Bob White Lake is based on narrative criteria. There are no numeric criteria for siltation applicable to Bob White Lake or its sources in Chapter 61 of the Iowa Water Quality Standards (IAC, 1996). Various proposals for how to develop numeric criteria are being considered, but no good numeric measure currently exists. An indirect measure of sediment is accomplished by demonstrating the linkages between excess sediment and the impacts to aquatic life. Since excessive sediment deposition has impacted this water body, the target needs to include a sediment load to the lake and measurement of the aquatic life within the lake. Therefore, this TMDL will incorporate two target phases.

Target One

The Phase I target will deal with direct deposition of eroded sediment delivered to the lake. A direct measure of the sediment load is difficult, given seasonal variability and actual measurement tools. Acceptable estimates using established soil loss equations can be made to predict the erosion rates in the watershed, and subsequent delivery to the lake.

Target number one for Bob White Lake is to reduce the total erosion rate. The sources are sheet and rill, streambank erosion, and gully erosion. Maintaining the gross erosion rate from fields in the watershed at or below “T”; reducing the streambank erosion by 50%; and eliminating the contribution from gully erosion would reduce the corresponding delivery to the lake. “T” is an estimate of the maximum average annual rate of erosion by wind or water that can occur without affecting crop productivity over a sustained period” (USDA-SCS, 1990). Reducing the total erosion rate in the Bob White Lake watershed is expected to result in the protection of aquatic life and primary contact recreation by eliminating the adverse effects of excessive sediment loading to Bob White Lake. This sediment load target is a reasonable initial estimate of measures necessary to result in an average rate of deposition in the lake low enough to minimize the impact on aquatic life.

The sediment delivery targets were calculated using the Erosion and Sediment Delivery Procedure, Section I, Erosion Protection (USDA/NRCS, 1998). Target values incorporating an erosion factor T, calculated from these delivery predictions, are in tons of sediment delivered per year. The resultant target for this TMDL for Bob White Lake will be 3,870 tons/year of sediment delivered to the lake.

Target Two

The Phase II target for this TMDL will be achieved when the fishery of Bob White Lake is determined to be fully supporting the Class B aquatic life uses. This determination will be accomplished through an assessment conducted by the DNR Fisheries Bureau in either 2001 or 2002. The DNR Fisheries Bureau will conduct an assessment of Bob White Lake in accordance with the Statewide Biological Sampling Plan protocol (Larscheid, 2001) by the end of the 2002 season to characterize the condition of aquatic life. IDNR Fisheries Bureau is using this protocol to help develop benchmarks for fishery integrity in Iowa lakes. Sampling techniques for these surveys are outlined in “Standard Gear and Techniques for Fisheries Surveys in Iowa”, 1995. This assessment will include growth, size structure, body condition, relative abundance, and species.

Bob White Lake will not be considered restored until the second target is achieved. If the aquatic life target is achieved prior to the sediment delivery target, then the level of conservation practices implemented at the time of the assessment may become the baseline for the watershed. If however, after a reasonable time following the completion of the sediment delivery practices the aquatic life use has not been restored, then further study and practices may be necessary.

6. Loading Capacity

The Iowa DNR has determined that reducing the gross erosion rate from fields in the watershed to T will enable the lake to meet water quality standards. “T is an estimate of the maximum average annual rate of erosion by wind or water that can occur without affecting crop productivity over a sustained period” (USDA-SCS, 1990). The erosion factor T in Bob White Lake watershed is 3.17 t/a/y. Using an average delivery rate of 34% (from Rathbun report)) yields approximately 1 t/a/y sediment delivery to the lake at T. This calculates to 3,732 tons/year of sediment delivered from sheet and rill and 138 /yr from streambank erosion. The load capacity is therefore 3,870 t/yr of sediment delivered to the lake.

7. Pollutant Sources

Water quality in Bob White Lake is influenced only by non-point sources. There are no point source discharges in the watershed. Nonpoint source pollution is caused by material transported to the lake by runoff from the watershed. Gully, streambank/streambed, sheet and rill, and shoreline erosion can contribute significantly to poor water quality and deterioration of the lake. There is minimal contribution from shoreline erosion.

Although all land within a watershed contributes to sediment runoff, the main source of this pollutant in the Bob White Lake watershed is sheet and rill erosion from agricultural fields. There is a significant contribution from gullies, both classic and ephemeral, and from streambank erosion in the Bob White Lake watershed. The target load of T has already been achieved throughout the watershed.

8. Pollutant Allocation

8.1 Point Sources

There are no point source discharges within the Bob White Lake watershed, so the Wasteload Allocation established under this TMDL is zero.

8.2 Non-Point Sources

Production agriculture dominates the watershed of Bob White Lake. Non-point source erosion accounts for almost all sediment entering the lake. There is a contribution from sheet and rill erosion, there are gullies present in the watershed, and there is a contribution from streambank erosion. Shoreline erosion stabilization has been conducted, eliminating a contribution from that source.

The sediment delivery to Bob White Lake was then calculated (Equation, Section 2.1) using the gross erosion rate of 3.17 t/a/y, which is T for this watershed. The Sediment Delivery Rate is still 34% (Rathbun report, Appendix II). The Load Allocation established in support of the target of this TMDL is 3,870 tons of sediment per year delivered to Bob White Lake. Maintaining the delivery of sediment to the lake at or below the target will result in improved water quality by allowing the lake to “maintain a balanced community normally associated with lake-like conditions” (IAC, 1996).

The estimates in Table 3 for 1990 sediment delivery are only based on sheet and rill erosion and do not include a estimate for gully or streambank erosion, since those numbers were not available. The total sediment estimates for sheet and rill from the 1992 reporting period when compared to the load allocation therefore may not clearly demonstrate the overall reduction.

Table 3. Annual Sediment Delivery Load Allocations to Bob White Lake

Source	Acres	1990 Sediment Delivery	Current Conditions	Sediment Delivery Load Allocation
Sheet & rill	3,463	3,885	2,473	3,732
Classic Gully		*	142	0
Ephemeral		*	101	0
Streambank		*	276	138
Total	3,463	3,885	2,992	3,870

*****These values not available for the reporting period.

8.3 Load Allocation and Margin of Safety

An implicit margin of safety is recognized by virtue of the fact that the aquatic life use must be restored to Bob White Lake. The use of the two targets of 1) a sediment load reduction and 2) aquatic life assessment assures that the uses will be restored regardless of the accuracy of the sediment delivery targets. Failure to achieve water quality standards will trigger review and probable revision of the TMDL, allocations, and/or further sediment source management approaches.

9. Seasonal Variation

It is expected that the majority of all runoff and erosion in the Bob White Lake watershed occurs in the spring and early summer during periods of high rainfall when vegetative cover may be reduced. This TMDL recognizes that sediment loading and transport varies substantially from year to year as well as seasonally. In addition, sediment impacts are felt over longer timeframes, and predictions regarding those impacts can only be assessed over multi-year periods. Therefore, the Load Allocations in this document are appropriate when expressed as an average per year.

10. Monitoring Plan

The DNR Fisheries Bureau will conduct an assessment of Bob White Lake in accordance with the Statewide Biological Sampling Plan protocol (Larscheid, 2001) by the end of the 2002 season to characterize the condition of aquatic life. Sampling techniques for these surveys are outlined in “Standard Gear and Techniques for Fisheries Surveys in Iowa”, 1995. This assessment will include growth, size structure, body condition, relative abundance, and species.

Currently, in-lake water monitoring will be completed as part of the Iowa Lakes Survey, which includes sampling three times per year for each of the field seasons 2000 – 2004. That plan includes monitoring a number of parameters annually over a five-year period. Sampling includes total phosphorus in the water column, chlorophyll a in the lake to measure planktonic growth, total nitrogen, total suspended solids, and Secchi disc depth.

11. Implementation

The Iowa Department of Natural Resources recognizes that an implementation plan is not a required component of a Total Maximum Daily Load. However, the IDNR offers a two-phase implementation strategy as guidance to DNR staff, its partners, and watershed stakeholders in restoring Bob White Lake to its designated uses. A phased TMDL is used to create an initial "plan of attack", so to speak, to address the impairment with available information. The initial first step towards meeting water quality standards is to achieve and maintain the sediment delivery target. The second one is to evaluate the impact of that action.

There are two phases to addressing the water quality issues involved at Bob White Lake. The primary impacts of sediment at Bob White Lake are interference with reproduction and growth of fish and other aquatic life. Excessive sediment deposition has lead to the lake being assessed as not meeting water quality standards. Phase I of this TMDL reduces the sediment delivery to the lake. This will stop the continuing negative impact to the lake. Phase II includes the restoration of the fishery to a level that fully supports the Class B aquatic life uses.

Phase I: In support of Phase I, the Rathbun Land and Water Alliance (RLWA), under funds from a grant from Clean Water Act Section 319 has developed a plan to improve water quality in Bob White Lake. The Alliance project funded field investigations to determine landuses, cropping patterns, fertilizer use, conservation practices, livestock operations, and gully erosion were made in early 2001 by the local Soil and Water Conservation District (SWCD) office. Funds were also received through the IDALS/DSC Watershed Protection Fund and the Publicly Owned Lakes Fund. Construction projects funded by Section 319 grants are subject to the provisions of the Endangered Species Act. Any projects within the watershed that utilize federal funds will consider any endangered species. Several conservation practices have been already been implemented or are planned in the Bob White Lake watershed. Those include:

<u>Crop Ground</u>:	
12% Converted to pasture or hay land	281 acres
<u>Grade Stabilization Structures</u>:	
1-Northeast of lake completed 2001	7.5 Acres drainage
1-Southwest of lake to be completed 2002	10 Acres drainage
<u>Terraces</u>:	
Completed in the 2000-2001 season	6,600 ft.
To be completed in the 2001-2002 season	10,000 ft.
<u>Terrace renovation</u>:	
To be completed in the 2001-2002 season	70,000 ft.

There are a variety of BMPs that can help with erosion control and ultimately water quality. They include tillage practices such as contour, cross-slope, no till, and conservation tillage; terraces; grassed waterways; grade-stabilization structures; conservation cover; filter strips; buffers and riparian zones; and wetland development. Each has an impact directly related to the conditions they address, and often need to be used in combination to get the maximum benefit.

Any successful effort to reduce erosion and to slow runoff brings a corresponding reduction in the delivery of nutrients from the watershed. This would be true as well for other sources of water quality problems, such as herbicides and bacteria.

Phase II: As stated in Section 4, these sediment load targets are reasonable initial estimates to accomplish a resultant decrease in an average rate of deposition in the lake great enough to minimize the impact on aquatic life. A phased TMDL is used to address the impairment with available information. The initial first step towards meeting water quality standards is to substantially reduce the amount of sediment that will be delivered in the future. The information available clearly shows that that goal has already been accomplished in the majority of the watershed. The next step is to continue to assess conditions to support or to modify these initial targets. Phase II of this TMDL will evaluate monitoring and assessment data and determine if any further actions need to be taken. If the aquatic targets are not achieved, additional action may be required. Options could include removal of portions of the sediment, reestablishing rooted aquatic vegetation, or altering uses of the upper portions of the lake to better protect the lower, or northern, portions.

12. Public Participation

Public meetings regarding the procedure and timetable for developing the Bob White Lake TMDL were held on January 17, 2001, in Des Moines, Iowa; and on February 1, 2001 in Corydon, Iowa. Another meeting was held in Corydon, Iowa, on October 31, 2001 to discuss the draft document. Comments received, where appropriate, were incorporated into this document.

13. References

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14. Appendix I

PREDICTING RAINFALL EROSION LOSSES THE REVISED UNIVERSAL SOIL LOSS EQUATION (RUSLE)

The equation is expressed as follows: A = RKLSCP where:

A = average annual soil loss from inter-rill (sheet) and rill erosion caused by rainfall and its associated overland flow expressed in tons/ac/yr,

R = the factor for climatic erodibility,
K = the factor for soil erodibility measured under a standard condition,
L = the factor for slope length,
S = the factor for slope steepness,
C = the factor for cover-management, and
P = the factor for support practices.

Example calculation from Bob White Watershed:

A= ?	
R=180	rainfall factor
K=0.3	erodibility factor (by soil type)
LS=0.48	length / slope
CP=0.131	[cropping factor] [practice factor (ex: 90% reduction, 10% of load)]

A= (180) (0.3) (0.48) (0.131)
= 3.3955 t/a/y
= 3.4 t/a/y

SUMMARY OF INITIAL RESULTS FROM THE RATHBUN LAKE WATERSHED ASSESSMENT CONDUCTED UNDER A GRANT FROM EPA. (REPORT WILL BE AVAILABLE DECEMBER 31, 2001)

Sheet and Rill Erosion Calculations Using RUSLE:

1990-3293 T/Y/Delivered calculated by the DNR but does not include P factor
2001-2181 T/Y/Delivered calculated by the DNR includes P factor and current land use
1999-2000 – 3782 T/Y/Delivered calculated by Tyler but does not include P factor and based on 92 land use

Total Erosion Calculations Using USLE and Sediment and Erosion Delivery Procedure:

Data based on field data collection using P factors and including streambank, gully, ephemeral gully, and sheet and rill erosion
1999-2000 - 4611T/Y/Delivered

Streambank Erosion Estimate:
276 Tons Delivered/Yr @ 80% Delivery Rate
Gully Erosion Estimate:
142 Tons Delivered/Yr @ 80% Delivery Rate
Ephemeral Gully Erosion Estimate:
101 Tons Delivered/Yr @ 50% Delivery Rate
USLE Sheet and Rill Erosion Estimate:
4092 Tons Delivered/Yr @34% Delivery Rate

15. Appendix II

Bob White Lake Watershed